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RESEARCH ARTICLE OPEN ACCESS

Effect of Sugarcane press mud on the Geotechnical Properties of an Expansive Soil

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ABSTRACT
Expansive Soils are soils that have the ability to shrink and/or swell, and thus change in volume, in relation to changes in their moisture content. Expansive soil or clay is considered to be one of the more problematic soils and it causes damage to various civil engineering structures because of its swelling and shrinking potential when it comes into contact with water. Therefore it is essential to stabilize the expansive soil by suitable additives. Sugarcane press mud is the residue of the filtration of sugarcane juice. Large amounts of sugar cane press mud are released by the sugarcane industry and the disposal of this by-product is a major issue. Due to the presence of calcium it has the potential to enhance the geotechnical properties of soil. A study was made on the effects of variation of geotechnical properties of soil treated with 2%, 4%,6%,8% 10% of sugar cane press mud. It was found that there was an improvement in some geotechnical properties of an expansive soil. From this investigation it was found that sugarcane press mud can be utilized effectively in the stabilization of expansive soil where strength consideration is significant

Key Words- Expansive Soil, Compaction parameters, CBR, sugarcane press mud, unconfined compressive strength

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I. INTRODUCTION

Expansive Soils are soils that have the ability to shrink and/or swell, and thus change in volume, in relation to changes in their moisture content. They usually contain some form of expansive clay mineral, such as, montmorillonite or vermiculite, that are able to absorb water and swell, increasing in volume, when they get wet and shrink when they dry. Expansive soil or clay is considered to be one of the more problematic soils and it causes damage to various civil engineering structures because of its swelling and shrinking potential when it comes into contact with water Chijioke Christopher et al (2019). Expansive soils may cause Structural damage to lightweight structures such as sidewalks and driveways, Lifting of buildings, damage to basements, and building settlement, Cracks in walls and ceilings, Damage to pipelines and other public utilities, Lateral movement of foundations and retaining walls due to pressure exerted on vertical walls, Loss of residual shear strength causing instability of slopes, etc. Therefore it is essential to stabilize the expansive soil by suitable additives. Masoumeh Mokhtari et al(2012)

Sugarcane press mud is the residue of the filtration of sugarcane juice. The clarification process separates the juice into a clear juice that rises to the top and goes for manufacture, and a mud that collects at the bottom. The mud is then filtered to separate the suspended matter, which includes insoluble salts and fine bagasse. This industrial waste is mostly used as soil conditioner, soil fertilizer and for wax production. Other industrial applications are reported (cement and paint manufacturing, foaming agent, composting aid for bagasse, etc.) and it has been used as human food by resource-poor families. In animal production, it has been used as feed ingredient, notably for ruminants, because of its sugar and mineral content. But use of sugar cane press mud in soil stabilization is rare.

Jasbir Saini (2019) investigated and reported that addition of sugar cane press mud lead to the increase in optimum moisture content and decrease in Maximum Dry density.CBR values UCS values improved upto 5% of Sugar cane press mud then decreases

Jijo James (2019) have been made experimental investigations to study the effect of sugar cane press mud on strength characteristics of an expansive soil. He observed that increase in

strength of soil with the addition of sugar cane press mud.

Biffi et al (2018) after extensive research reported that the unconfined compressive strength of the treated soil was observed to be improving on adding press mud to soil and increase in curing period.

Due to the presence of calcium it has the potential to enhance the geotechnical properties of soil. Hence an attempt is made to study the effect of sugarcane press mud on some Geotechnical properties of an expansive soil.

II. EXPERIMENTAL INVESTIGATIONS

2.1. Materials used

2.1.1Soil

The soil used for this investigation is obtained from Gajula Mandyam, Tirupati. The dried and pulverized material passing through I.S.4.75 mm sieve is taken for the study. The properties of the soil are given in Table.1.The soil is classified as "CH" as per I.S. Classification (IS 1498:1970) indicating that it is Highly Compressible Clay. It is highly expansive in nature as the Differential Free Swell Index (DFSI) is about 65%.

Table: 1 Properties of Untreated soil

Property	Value
Grain size distribution	
(a) Gravel (%)	3
(b) Sand (%)	16
(c) Silt+Clay (%)	81
Atterberg Limits	
(a)Liquid Limit (%)	62
(b)Plastic Limit (%)	28
(c) Plasticity Index (%)	34
Differential Free Swell Index (%)	65
Specific Gravity	2.76
Maximum Dry Unit Weight (kN/m^3)	14.7
Optimum moisture content (%)	20.2
CBR Value at 2.5mm penetration (%)	5.5
Unconfined Compressive strength (KN/m^2)	213.2
Swelling pressure of Soil (KN/m^2)	311

2.2.2. Sugarcane press mud

The sugar sugarcane press mud is obtained from Sri Venkateswara Co-op. Sugar Factory Ltd. near Gajula mandyam, Tirupati. The chemical properties of the sugarcane press mud are shown in Table. 2 (James and Pandian, 2016b).

Table: 2 chemical properties of the sugarcane press mud

SiO_2	Al_2O_3	CaO	Fe_2O_3	K_2O
25.5	2.4	18.5	5.8	1.3
MgO	Na_2O	P_2O_5	TiO_2	SO_3
3.1	0.1	7.2	0.2	0.4

III. PROCEDURE FOR MIXING

The soil from the site is dried and hand sorted to remove the pebbles and vegetative matter if any. It is further dried and pulverized and sieved through a sieve of 4.75mm to eliminate gravel fraction if any. The dried and sieved soil is sorted in air tight containers ready for use for mixing with additives. The soil mixed with water of chosen moisture content and stored of a day for uniform distribution of water in different containers. The soil sample so prepared is then mixed with Sugarcane press mud. The percentage weight varied from 2% to 10% in increment of 2%.The soil sugarcane press mud mixtures are mixed thoroughly before testing.

IV. TESTS ON TREATED SOIL

4.1. Standard Proctor Test

The compaction parameters optimum moisture content and Maximum dry unit weight play a vital role in changing the strength characteristics of an Expansive soil. But these two parameters are influenced by sugarcane press mud. Hence in this investigation Standard Proctor's compaction tests are carried out on expansive soil treated with sugarcane press mud at various percentages of 2%, 4%, 6%, 8% and 10% by dry weight of the soil.

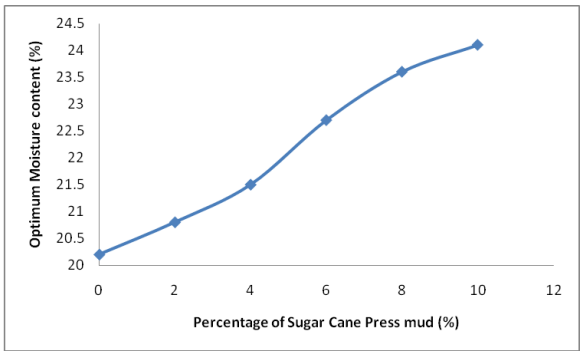

Fig: 1: Variation of Optimum moisture content with per cent sugarcane press mud.

The results of the Standard Proctor's compaction tests, conducted at different percentages of sugar cane press mud are reported in Fig.1 and

Fig.2.From the figure.1 it is observed that as the percentage of sugarcane press mud increases the optimum moisture content increases due to better moisture holding capacity of sugar cane press mud. The optimum moisture content of untreated soil is 20.2%.The optimum moisture content at 10% of sugarcane press mud is 24.1%

From the figure.2 it is observed that as the percentage of sugarcane press mud increases the dry density decreases. It may be due to aggregation/flocculation and forms the cementitious products. The Maximum dry unit weight of untreated soil is 14.7 KN/m^3.The Maximum dry unit weight at 10% of alum sludge is 12.6KN/m^3.

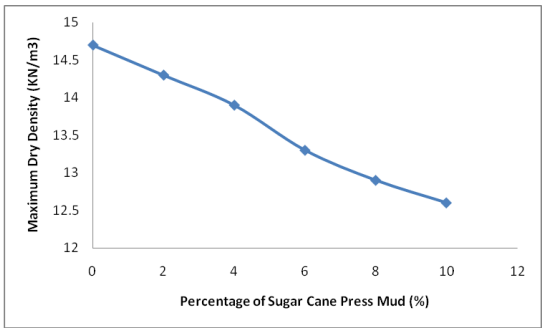

Fig:2: Variation of Maximum Dry Unit Weight with Per cent sugarcane press mud.

4.2. California Bearing Ratio Test

The strength of the sub grade is an important factor in the determination of the thickness required for a flexible pavement. It is expressed in terms of its "California Bearing Ratio", usually abbreviated as CBR. If CBR values are more it indicates strength of sub grade is strong and we can opt lesser thickness of pavement. The California Bearing Ratio value is determined corresponding to both 2.5 mm and 5.0 mm penetrations, and the greater value is used for the design of flexible pavement.

In this investigation California Bearing Ratio tests on Expansive soil treated with sugar cane press mud varying from 2% to 10% in increment of 2% is carried out. The tests are conducted on remolded soil specimens at their respective optimum moisture content and Maximum Dry Unit Weights and compacted according to I.S. Light compaction.

The variation of the CBR values with different percentages of sugarcane press mud is shown in Fig.3.From the figure it is observed that as the percentage of sugarcane press mud increases CBR values increases up to 6% then decreases. The initial CBR value of untreated soil is 5.5%.The maximum increase in CBR value obtained at 6% of sugarcane press mud and is 10.8%. The increase in CBR value is due to increase in bond between soil and sugar cane press mud and frictional resistance that has been worked out from sugar cane press mud.

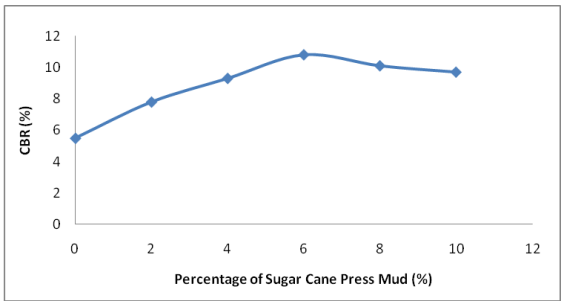

Fig: 3: Variation of CBR value of soil with percent sugarcane press mud

4.3. Unconfined Compressive Strength test (UCS)

Undrained shear strength is estimated as half of the Unconfined Compressive Strength. Hence Unconfined Compressive Strength is conducted on the treated and untreated soil. This is a special case of Triaxial Compression Test. The confining pressure being zero. A cylindrical soil specimen, usually of the same size as that for the Triaxial Compression Test, is loaded axially by a compressive force until failure takes place. Since the specimen is laterally unconfined, the test is known as Unconfined Compression Test. No rubber membrane is necessary to encase the specimen. The axial or vertical compressive stress is major principal stress and the other two principal stresses are zero.

In this investigation, Unconfined Compressive Strength (UCS) test is, carried out to study the strength behaviour of soil treated with different percentages of sugarcane press mud. The variation in unconfined compressive Strength with respect to different percentages of sugarcane press mud is shown in Fig.4. From the figure, it is observed that as the percentage of sugar cane press mud increases UCS values increases up to 6% then decreases. The unconfined compressive strength value of untreated soil is 213.2 kN/m^2. The maximum increase in UCS values obtained at 6% of sugarcane press mud and is 248.3 kN/m^2. The increase in UCS value is due to increase in bond between soil and sugar cane press mud.

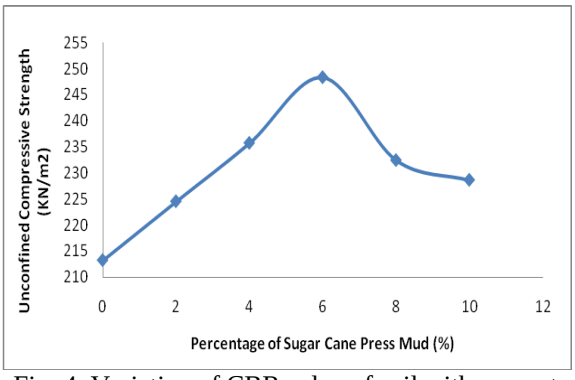

Fig: 4: Variation of CBR value of soil with percent Sugarcane press mud

4.4. Swelling Characteristics

The swelling nature of soil causes lot of damages and severe cracks in Civil Engineering structures constructed over it. Light weight structures are severely affected due to high swelling pressure exerted by these soils. In this investigation the swelling pressure of soil is measured for 'no volume change' condition. The method requires continuous adjustment of pressure on the soil specimen taken in a consolidation cell, so that the soil volume at any time is equal to its initial volume.

In this investigation swelling pressure of an Expansive soil treated with sugarcane press mud varying from 2% to 10% in increment of 2% is carried out. The swelling pressure of untreated soil is 311 kN/m^2. But it is observed that the addition of sugarcane press mud does not cause any detrimental changes in swelling pressure of soil. It may be due to sugarcane press mud being a material of organic origin.

V. SUMMARY AND CONCLUSIONS

Expansive soil or clay is considered to be one of the more problematic soils and it causes damage to various Civil Engineering structures because of its swelling and shrinking potential when it comes into contact with water. Hence Stabilization of expansive soil with suitable additives is essential. In this work, the performance of sugar cane press mud in expansive soil stabilization was examined via laboratory investigation. Different tests like Compaction test, CBR and UCS test were conducted. Addition of sugar cane press mud increases optimum moisture content and decreases the maximum dry density.CBR and UCS values improved up to 6% then decreases. But it does not cause any significant changes in swelling pressure. Hence It is suggested that sugar cane press mud of 6% by weight of soil can be utilized as an effective soil stabilizer if available in abundant quantity where strength of soil is major consideration than swelling pressure. The results are based only on laboratory investigations and hence it is further recommended that the effectiveness and long-term performance in the fled, of this material, should be found in actual soil stabilization projects.

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